PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Assistant Commissioner for Patents
United States Patent and Trademark Office
Box PCT
Washington, D.C.20231
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 22 June 2000 (22.06.00)	
International application No. PCT/FI99/00771	**Applicant's or agent's file reference** 2980385PC/nu
International filing date (day/month/year) 20 September 1999 (20.09.99)	**Priority date** (day/month/year) 21 September 1998 (21.09.98)
Applicant HURTTA, Tuija	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

19 April 2000 (19.04.00)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer C. Villet
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

RECORD COPY

PCT REQUEST

2980385PC/nu

Original (for **SUBMISSION**) - printed on 20.09.1999 11:00:30 AM

0 0-1	**For receiving Office use only** International Application No.	PCT/FI 9 9 / 0 0 7 7 1
0-2	International Filing Date	20 SEP 1999 (20.09.99)
0-3	Name of receiving Office and "PCT International Application"	The Finnish Patent Office PCT International Application
0-4 0-4-1	**Form - PCT/RO/101 PCT Request** Prepared using	PCT-EASY Version 2.84 (updated 01.07.1999)
0-5	**Petition** The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	**Receiving Office (specified by the applicant)**	National Board of Patents and Registration (Finland) (RO/FI)
0-7	**Applicant's or agent's file reference**	2980385PC/nu
I	**Title of invention**	IP MOBILITY MECHANISM FOR A PACKET RADIO NETWORK
II II-1 II-2 II-4 II-5 II-6 II-7	**Applicant** This person is: Applicant for Name Address: State of nationality State of residence	 applicant only all designated States except US NOKIA TELECOMMUNICATIONS OY Keilalahdentie 4 FIN-02150 Espoo Finland FI FI
III-1 III-1-1 III-1-2 III-1-4 III-1-5 III-1-6 III-1-7	**Applicant and/or inventor** This person is: Applicant for Name (LAST, First) Address: State of nationality State of residence	 applicant and inventor US only HURTTA, Tuija Kiskottajankuja 4 D 49 FIN-02660 Espoo Finland FI FI

IV-1	**Agent or common representative; or address for correspondence** The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	agent
IV-1-1	Name	KOLSTER OY AB
IV-1-2	Address:	Iso Roobertinkatu 23 P.O. Box 148 FIN-00121 Helsinki Finland
IV-1-3	Telephone No.	358 9 618 821
IV-1-4	Facsimile No.	358 9 602 244
IV-1-5	e-mail	kolster@kolster.fi
V	**Designation of States**	
V-1	Regional Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AP: GH GM KE LS MW SD SL SZ UG ZW and any other State which is a Contracting State of the Harare Protocol and of the PCT EA: AM AZ BY KG KZ MD RU TJ TM and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT EP: AT BE CH&LI CY DE DK ES FI FR GB GR IE IT LU MC NL PT SE and any other State which is a Contracting State of the European Patent Convention and of the PCT OA: BF BJ CF CG CI CM GA GN GW ML MR NE SN TD TG and any other State which is a member State of OAPI and a Contracting State of the PCT
V-2	National Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AE AL AM AT (patent and utility model) AU AZ BA BB BG BR BY CA CH&LI CN CR CU CZ (patent and utility model) DE (patent and utility model) DK (patent and utility model) DM EE (patent and utility model) ES FI (patent and utility model) GB GD GE GH GM HR HU ID IL IN IS JP KE KG KP KR KZ LC LK LR LS LT LU LV MD MG MK MN MW MX NO NZ PL PT RO RU SD SE SG SI SK (patent and utility model) SL TJ TM TR TT TZ UA UG US UZ VN YU ZA ZW

PCT REQUEST

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V-5	**Precautionary Designation Statement** In addition to the designations made under items V-1, V-2 and V-3, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except any designation(s) of the State(s) indicated under item V-6 below. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit.		
V-6	**Exclusion(s) from precautionary designations**	NONE	
VI-1	**Priority claim of earlier national application**		
VI-1-1	Filing date	21 September 1998 (21.09.1998)	
VI-1-2	Number	982028	
VI-1-3	Country	FI	
VI-2	**Priority document request** The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s):	VI-1	
VII-1	**International Searching Authority Chosen**	Swedish Patent Office (ISA/SE)	
VIII	**Check list**	number of sheets	electronic file(s) attached
VIII-1	Request	4	-
VIII-2	Description	8	-
VIII-3	Claims	2	-
VIII-4	Abstract	1	2980385p.txt
VIII-5	Drawings	1	-
VIII-7	TOTAL	16	
	Accompanying items	paper document(s) attached	electronic file(s) attached
VIII-8	Fee calculation sheet	✓	-
VIII-10	Copy of general power of attorney	✓	-
VIII-16	PCT-EASY diskette	-	diskette
VIII-17	Other (specified):	Copy of Official Action	-
VIII-18	**Figure of the drawings which should accompany the abstract**	1 and 2	
VIII-19	**Language of filing of the international application**	English	
IX-1	**Signature of applicant or agent**	Tapio Valkeiskangas	
IX-1-1	Name	KOLSTER OY AB	

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10-1	**Date of actual receipt of the purported international application**	20 SEP 1999	(20 -09- 1999)

PCT REQUEST

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Original (for SUBMISSION) - printed on 20.09.1999 11:00:30 AM

10-2 10-2-1 10-2-2	Drawings: Received Not received	
10-3	Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application	
10-4	Date of timely receipt of the required corrections under PCT Article 11(2)	
10-5	International Searching Authority	ISA/SE
10-6	Transmittal of search copy delayed until search fee is paid	

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11-1	Date of receipt of the record copy by the International Bureau	

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 2980385PC/su	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/FI99/00771	International filing date *(day/month/year)* 20.09.1999	Priority date *(day/month/year)* 21.09.1998
International Patent Classification (IPC) or national classification and IPC7 H 04 Q 7/22, H 04 L 29/06		
Applicant Nokia Networks OY et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 7 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of _____ sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☒ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☒ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
19.04.2000	04.09.2000
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Telex 17978 PATOREG-S Facsimile No. 08-667 72 88	Authorized officer Nabil Ayoub/mj Telephone No. 08-782 25 00

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PR[redacted]INARY EXAMINATION REPORT

[redacted]rnational application No.
PCT/FI99/00771

I. Basis of the report

1. This report has been drawn on the basis of *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.)*:

☒ the international application as originally filed.

☐ the description, pages _____ , as originally filed,
pages _____ , filed with the demand,
pages _____ , filed with the letter of _____ ,
pages _____ , filed with the letter of _____ .

☐ the claims, Nos. _____ , as originally filed,
Nos. _____ , as amended under Article 19,
Nos. _____ , filed with the demand,
Nos. _____ , filed with the letter of _____ ,
Nos. _____ , filed with the letter of _____ .

☐ the drawings, ~~sheets~~/fig _____ , as originally filed,
~~sheets~~/fig _____ , filed with the demand
~~sheets~~/fig _____ , filed with the letter of _____ ,
~~sheets~~/fig _____ , filed with the letter of _____ .

2. The amendments have resulted in the cancellation of:

☐ the description, pages _____
☐ the claims, Nos. _____
☐ the drawings, ~~sheets~~/fig _____

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the supplemental Box (Rule 70.2(c)).

4. Additional observations, if necessary:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/FI99/00771

II. Priority

1. ☐ This report has been established as if no priority had been claimed due to the failure to furnish within the prescribed time limit the requested:

   ☐ copy of the earlier application whose priority has been claimed.

   ☐ translation of the earlier application whose priority has been claimed.

2. ☐ This report has been established as if no priority had been claimed due to the fact that the priority claim has been found invalid.

Thus for the purpose of this report, the international filing date indicated above is considered to be the relevant date.

3. Additional observations, if necessary:

Priority is considered valid, therfore document WO 98 43446 is of no relevance.

INTERNATIONAL PR[redacted]INARY EXAMINATION REPORT

[redacted]national application No.
PCT/FI99/00771

V. Resoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1 - 11	YES
	Claims		NO
Inventive step (IS)	Claims	1 - 11	YES
	Claims		NO
Industrial applicability (IA)	Claims	1 - 11	YES
	Claims		NO

2. Citations and explanations

The claimed invention relates to a mechanism for providing Internet Protocol (IP) mobility in a packet radio network such as GPRS or UMTS.
The claimed invention discloses a method for providing Internet Protocol mobility for a mobile station in a packet radio network. A gate support node (GGSN) is interoperable with at least one home agent (HA) and at least one serving support node (SGSN), for routing data packets to/from the mobile station. The gate support node (GGSN) comprises the function of the home agent (HA) and is arranged to support Mobile IP protocol on the network layer. The protocol stack is streamlined by routing data packets to/from the integrated home agent/gateway node (GGSN+HA) using only the network layer protocol and the layer 2 and layer 1 protocols.

Document cited in the International Search Report:

D1: Wietfeld C. ET AL: "Seamless IP-based Integration across Fixed/Mobile and corporate/Public Networks", Vehicular Technology conference, 1999 IEEE 49th, volume: 3, pages 1930 - 1934
D2: WO, 9840988, A
D3: WO, 9621983, A

D1 describes how Internet technology can be used for seamless roaming while using public network access, which provides wireless technology. The IP network is connected to the radio access network via an Interworking Unit (IWU) which relay the basic transport and signalling protocols between both networks. When a mobile station moves to another location, the mobile station may attach to a different part of the radio access network and, thus to a different IWU. Consequently, the state information from the "old" IWU have to be transferred to the new one.

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: V.

D2 discloses an arrangement for providing access between a telecommunication station and a data network. The arrangement comprises access support means, which are connected to a server via which a connection can be set-up between a mobile station and a data network. When the mobile station is registered with the server, it is given a long term IP-address and a home network. The home address is administrated in the same way as a permanent IP-address is provided to a stationary host. The access support means sets up an association between the Internet protocol IP-address in a foreign agent of the data network with which the mobile station is registered and the server. When away from the home network, a care-of address is associated with the mobile station and reflects the current attachment point of the mobile station. The access support means registers the mobile station through the foreign agent to a home agent (HA) of the mobile station. When a data packet is sent to the mobile station. The home agent (HA) knows that the mobile station is registered at the foreign agent and the data packet intercepted by the home agent (HA) is tunnelled to the care-of address in the foreign agent. The data packet is then detunnelled by the foreign agent and sent to the mobile station.

D3 relates to a protocol-independent routing of data packets between a mobile station of a packet radio network and a host connected to an external network. A data packet of an extraneous protocol is transferred trough a packet radio network using a second protocol as encapsulated in a data packet according to the second protocol. A data packet network is connected to other packet radio networks via a gateway node (GPRS GSN), which uses the network internal protocol toward the dedicated packet network and the protocol of the packet radio network. When a data packet is transferred via the gateway node (GGSN) from the data packet network into the packet radio network, the data packet is encapsulated in a packet according to the protocol of the packet radio network. When the encapsulated data packet arrives in a node (SGSN) which supports the protocol of the encapsulated data packet, the encapsulated is stripped away and the data packet is routed forward to the mobile station.

.../...

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: V.

None of these documents disclose the use of a home agent integrated in the gateway support node neither the supplementation of IP-type protocol with an extension for mobility management of the mobile station, as defined in claims 1, 7, 10 and 11. It is not considered obvious to a person skilled in the art to use the method of any of the above mentioned documents so as to reach a method or arrangement as the one claimed in the present application.

To summarise:
The claimed invention in claims 1 - 11 is novel and is considered to involve an inventive step. The claimed invention in claims 1 - 11 is considered to have industrial applicability.

VI. Certain documents cited

1. Certain published documents (Rule 70.10)

Application No. Patent No.	Publication date *(day/month/year)*	Filing date *(day/month/year)*	Priority date (valid claim) *(day/month/year)*
WO 98/43446	01.10.98	24.03.98	25.03.97

2. Non-written disclosures (Rule 70.9)

Kind of non-written disclosure	Date of non-written disclosure *(day/month/year)*	Date of written disclosure referring to non-written disclosure *(day/month/year)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 99/00771

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04Q 7/22, H04L 29/06
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04Q, H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	WO 9843446 A2 (TELEFONAKTIEBOLAGET LM ERICSSON), 1 October 1998 (01.10.98), page 16, line 20 - page 19, line 7	1-11
A	Wietfeld C. ET AL: "seamless IP-based Integration accross Fixed/Mobile and Corporate/Public Networks" Vehicular Technology conference, 1999 IEEE 49th, volume: 3, pages 1950 - 1934, see page 1931 - 1932	1,7,10,11
A	WO 9840988 A1 (TELEFONAKTIEBOLAGET LM ERICSSON), 17 Sept 1998 (17.09.98), page 19, line 15 - page 22, line 2	1,7,10,11

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 March 2000	24 March 2000 (24.03.2000)
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Nabil Ayoub/cs Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 99/00771

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9621983 A1 (NOKIA TELECOMMUNICATIONS OY), 18 July 1996 (18.07.96), page 12, line 29 - page 18, line 3	1,7,10,11

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INTERNATIONAL SEARCH REPORT
Information on patent family members

02/12/99

International application No.
PCT/FI 99/00771

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9843446 A2	01/10/98	AU 6531598 A	20/10/98
WO 9840988 A1	17/09/98	AU 3052897 A	05/01/98
		AU 6427498 A	29/09/98
		DE 29780445 U	26/08/99
		SE 9700895 A	14/09/98
WO 9621983 A1	18/07/96	AU 702765 B	04/03/99
		AU 4392896 A	31/07/96
		CA 2209715 A	18/07/96
		CN 1173954 A	18/02/98
		EP 0804844 A	05/11/97
		FI 1989 U	06/07/95
		FI 98586 B,C	27/03/97
		FI 950116 A,V	11/07/96
		JP 10512409 T	24/11/98
		NO 973177 A	09/09/97
		US 5970059 A	19/10/99

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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : H04Q 7/22, H04L 29/06

A3

(11) International Publication Number: **WO 00/18154**

(43) International Publication Date: 30 March 2000 (30.03.00)

(21) International Application Number: PCT/FI99/00771

(22) International Filing Date: 20 September 1999 (20.09.99)

(30) Priority Data:
982028 21 September 1998 (21.09.98) FI

(71) Applicant *(for all designated States except US)*: NOKIA NETWORKS OY [FI/FI]; Keilalahdentie 4, FIN–02150 Espoo (FI).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: HURTTA, Tuija [FI/FI]; Kiskottajankuja 4 D 49, FIN–02660 Espoo (FI).

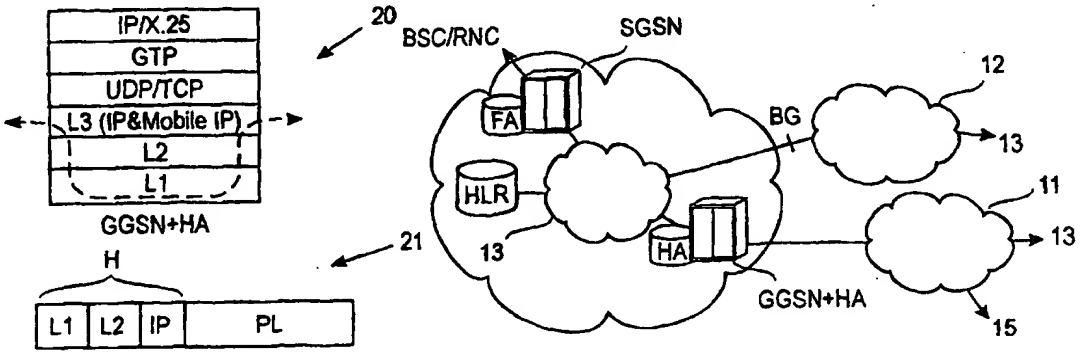
(74) Agent: KOLSTER OY AB; Iso Roobertinkatu 23, P.O. Box 148, FIN–00121 Helsinki (FI).

(81) Designated States: AE, AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), DM, EE, EE (Utility model), ES, FI, FI (Utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(88) Date of publication of the international search report:
8 June 2000 (08.06.00)

(54) Title: IP MOBILITY MECHANISM FOR A PACKET RADIO NETWORK



(57) Abstract

A gateway support node (GGSN+HA) for a packet radio network, arranged to provide Internet Protocol, or IP, mobility for a mobile station (MS). The gateway support node (GGSN+HA) is interoperable with at least one home agent (HA) and at least one serving support node (SGSN), for routing data packets to/from the mobile station (MS). It comprises a protocol stack (18, 20) for supporting at least a layer 1 (L1) protocol, a layer 2 (L2) protocol, and a network layer (L3) protocol, the network layer (L3) protocol supporting at least IP protocol. It also comprises the functions of the home agent (HA) and it is arranged to support Mobile IP protocol on the network layer (L3). Preferably, the protocol stack (20) is streamlined by routing data packets to/from the integrated home agent/gateway node (GGSN+HA) using only the network layer (L3) protocol and the layer 2 and layer 1 protocols.

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Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

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EE	Estonia	**LR**	Liberia	**SG**	Singapore		

IP mobility mechanism for a packet radio network

Background of the invention

The invention relates to a mechanism for providing IP (Internet Protocol) mobility in a packet radio network such as GPRS or UMTS. IP mobility is the topic of standard RFC2002 by the Internet Engineering Task Force (IETF). This RFC standard is incorporated herein by reference. In short, IP mobility is a mechanism for providing a mobile user with telecommunications capability using an IP address. It enables mobile nodes to change their points of attachment in the Internet without changing their IP address. Thus it facilitates the communication of a mobile node and a correspondent node with the mobile node's home address. Fig. 1 illustrates the concept of an IP mobility mechanism in a packet radio network.

Within the context of this application, a 'Network Access Server (NAS)' is a device providing users with temporary, on-demand network access. This access is point-to-point using telephone, ISDN or cellular connections, etc. A 'Mobile Node (MN)' refers to a host that wishes to use a Home Network address while physically connected by a point-to-point link (phone line, ISDN, etc.) to a NAS that does not reside on the Home Network. A 'Correspondent node' is a peer node with which a mobile node is communicating. The correspondent node may be either mobile or stationary. A 'Mobile Station (MS)' is a mobile node having a radio interface to the network. A 'Tunnel' is the path followed by a datagram when encapsulated. The model of a tunnel is such that, while encapsulated, a datagram is routed to a known decapsulation agent, which decapsulates the datagram and then correctly delivers it to its ultimate destination. Each mobile node connecting to a home agent does so over a unique tunnel, identified by a tunnel identifier which is unique to a given Foreign Agent/Home Agent pair.

The MS can be a laptop computer PC connected to a packet radio-enabled cellular telephone. Alternatively, the MS can be an integrated combination of a small computer and a packet radio telephone, similar in appearance to the Nokia Communicator 9000 series. Yet further embodiments of the MS are various pagers, remote-control, surveillance and/or data-acquisition devices, etc.

The Radio Access Network RAN can be a part of a GPRS system or a third generation (3G) system, such as UMTS. The RAN comprises an air interface Um which is a performance bottleneck. SGSN and GGSN are GPRS

terms for access and gateway support nodes, respectively. In so-called third generation (3G) systems, the SGSN nodes are sometimes referred to as 3G-SGSN nodes. Subscriber information is stored permanently in the Home Location Register HLR.

A 'Home Network' is the address space of the network to which a user logically belongs. When a workstation is physically connected to a LAN, the LAN address space is the user's home network. A 'Home Address' is an address that is assigned to a mobile node for an extended period of time. It may remain unchanged regardless of where the MN is attached to the Internet. Alternatively, it could be assigned from a pool of addresses. A 'Home Agent' is a routing entity in a mobile node's home network which tunnels packets for delivery to the mobile node when it is away from home, and maintains current location information for the mobile node. It tunnels datagrams for delivery to, and detunnels datagrams from, a mobile node when the mobile node is away from home.

A 'Foreign Agent' refers to a routing entity on a mobile node's visited network which provides routing services to the mobile node while registered, thus allowing a mobile node to utilise its home network address. The foreign agent detunnels and delivers packets to the mobile node that were tunnelled by the mobile node's home agent. For datagrams sent by a mobile node, the foreign agent may serve as a default router for registered mobile nodes.

RFC2002 defines 'Care-of-Address' (COA) as the termination point of a tunnel toward a mobile node, for datagrams forwarded to the mobile node while it is away from home. The protocol can use two different types of care-of-address: a "foreign agent care-of-address" is an address of a foreign agent with which the mobile node is registered, and a "co-located care-of-address" is an externally obtained local address which the mobile node has associated with one of its own network interfaces. Within the context of this application, the 'Care-of Address' (COA) is an address of a foreign agent with which the mobile node is registered. An MN may have several COAs at the same time. A primary COA is the address which the MN sends to its HA when registering. The list of COAs is updated when advertisements are received by the mobile node. If an advertisement expires, its entry or entries should be deleted from the list. One foreign agent can provide more than one COA in its advertisements. 'Mobility Binding' is the association of a Home Address with a Foreign

Agent IP address and a Tunnel ID. An MN registers its COA with its HA by sending a Registration Request. The HA replies with a Registration Reply and retains a binding for the MN.

In basic versions of Mobile IP, all datagrams destined to an MN are routed via the MN's home network and home agent HA. This process is called triangle routing. It may increase the load of the network and the HA may be a performance bottleneck. So-called route optimization protocol extensions for Mobile IP aim to eliminate the problems associated with triangle routing. In route optimization, correspondent nodes and previous FAs may retain an up-to-date binding for the MN in their binding caches. As a result, the correspondent nodes may tunnel their datagrams directly to the MN's COA and previous FAs may forward datagrams destined to the MN to the MN's current COA. The binding may be retained after reception of a Binding Update. If requested, a node should acknowledge the reception by sending a Binding Acknowledge. These messages must be authenticated. They are typically carried by User Datagram Protocol (UDP).

Routing data packets to an MN is a problem in a packet radio network, such as the GPRS. This is because the data network address of the MN typically has a static routing mechanism, whereas a MN can roam from one subnetwork to another. One approach for data packet routing in a mobile environment is the concept of Mobile IP. Mobile IP enables the routing of IP datagrams to mobile hosts, independent of the point of attachment in the subnetwork.

The standard Mobile IP concept does not fit exactly into the GPRS environment because network protocols other than IP must be supported, too. The GPRS infrastructure comprises support nodes such as a GPRS gateway support node (GGSN) and a GPRS serving support node (SGSN). The main functions of the GGSN nodes involve interaction with the external data network. The GGSN updates the location directory using routing information supplied by the SGSNs about an MS's path and routes the external data network protocol packet encapsulated over the GPRS backbone to the SGSN currently serving the MS. It also decapsulates and forwards external data network packets to the appropriate data network and handles the billing of data traffic.

The main functions of the SGSN are to detect new GPRS mobile stations in its service area, handle the process of registering the new MSs

along with the GPRS registers, send/receive data packets to/from the GPRS MS, and keep a record of the location of the MSs inside of its service area. The subscription information is stored in a GPRS register where the mapping between a mobile's identity (such as MS-ISDN or IMSI) and the PSPDN address is stored. The HLR acts as a database from which the SGSNs can ask whether a new MS in its area is allowed to join the GPRS network.

The GPRS gateway support nodes GGSN connect an operator's GPRS network to external systems, such as other operators' GPRS systems, data networks 11, such as an IP network (Internet) or an X.25 network, and service centres. Fixed hosts 14 can be connected to the data network 11 e.g. by means of a local area network LAN and a router 15. A border gateway BG provides access to an inter-operator GPRS backbone network 12. The GGSN may also be connected directly to a private corporate network or a host. The GGSN includes GPRS subscribers' PDP addresses and routing information, i.e. SGSN addresses. Routing information is used for tunnelling protocol data units PDU from the data network 11 to the current switching point of the MS, i.e. to the serving SGSN. The functionalities of the SGSN and GGSN can be connected to the same physical node.

The home location register HLR of the GSM network contains GPRS subscriber data and routing information and it maps the subscriber's IMSI into one or more pairs of PDP type and PDP address. The HLR also maps each PDP type and PDP address pair into a GGSN node. The SGSN has a Gr interface to the HLR (a direct signalling connection or via an internal backbone network 13). The HLR of a roaming MS and its serving SGSN may be in different mobile communication networks.

The intra-operator backbone network 13, which interconnects an operator's SGSN and GGSN equipment can be implemented, for example by means of a local network, such as an IP network. It should be noted that an operator's GPRS network can also be implemented without the intra-operator backbone network, e.g. by providing all features in one computer.

A GPRS network in its current form is able to support IP mobility if a MS implements the Mobile IP protocol and if it has a private IP address assigned by some company or Internet service provider (ISP). When a GGSN node assigns a temporary IP address to the MS, the MS can use this temporary address as its care-of-address (COA) and register the address with its home agent, thus benefiting from the Mobile IP services. This is also true

when the MS is using a predefined GGSN IP address, which can also be regarded as a COA. The only entity that can prevent the MS from using the GGSN-assigned IP address as its COA is a foreign agent (FA) whose agent advertisement messages are received by the MS and which require the MS to register with that particular FA.

A problem of the known IP mobility mechanisms is poor integration with packet radio systems. In other words, the known IP mobility mechanisms are designed, at least primarily, for wired access systems. This is turn has the side effect that each datagram is processed though a large number of different protocol layers, which involves a large processing overhead. Also, equipping each datagram with a large number of protocol headers wastes the capacity of the network.

Disclosure of the invention

An object of the invention is to improve the integration between IP mobility mechanisms and packet radio systems. In other words, the invention should solve, or at least minimize, the problems associated with the prior art IP mobility mechanisms. The object is achieved with a method and equipment which are characterized by what is disclosed in the attached independent claims. Preferred embodiments of the invention are disclosed in the attached dependent claims.

The invention is based on the vision that a home agent HA is installed at the edge of the packet radio network. Such a location allows the HA to decide whether to route datagrams addressed to a mobile subscriber using GPRS/GTP or Internet/IP. Preferably, the HA is integrated or consolidated into a gateway support node of a packet radio network. In a GPRS network, suitable gateway support nodes are the GGSN nodes. Each connection has two PDP contexts in the GGSN. One context corresponds to the fixed IP address stored in the subscribers home-GGSN, and the other corresponds to a dynamic address stored in the visited GGSN. In terms of mobility management (MM), the invention enables the use of two coexisting MM contexts, a GPRS MM context and a Mobile IP context. The integration of the home agent to the subscriber's home GGSN decides which MM context should be used for routing a datagram.

A further advantage of the invention is that Mobile IP support becomes a service provided by the network operator. Thus the operator can also charge the users for this service.

According to a preferred embodiment of the invention, the protocol stack used for routing data packets (i.e. datagrams) at the integrated gateway node/home agent is streamlined by routing data packets directly using network layer (i.e. layer 3) protocols. This embodiment results in increased throughput and/or lighter overhead due to a smaller protocol stack at the integrated gateway node/home agent, when routing IP datagrams.

According to another preferred embodiment of the invention, foreign agents FA are installed in SGSN nodes. Such placement of foreign agents maximizes the benefits of the invention, since it maximizes the span of the network that can be covered with the smaller protocol stack. (Currently, the IP tunnel ends at the SGSN. If the IP tunnel is extended into the Radio Access Network RAN, then, preferably, the foreign agents FA should also be moved to the RAN. In such a case, a possible network element could be the BSC/RNC.)

Alternatively, the FAs can be installed at the GGSN but then a GTP tunnel is required for routing IP packets between the GGSN and the SGSN. As a yet further alternative, the FAs can be omitted altogether, if IPv6 and a technique known as address autoconfiguration is used.

Brief description of the drawings

The invention will be described in more detail by means of preferred embodiments with reference to the appended drawing on which:

Fig. 1 illustrates an IP mobility mechanism comprising a known home agent HA and routing of datagrams at the HA; and

Fig. 2 illustrates an IP mobility mechanism comprising a home agent HA according to the invention and routing of datagrams at the HA.

Detailed description of the invention

Fig. 1 is block diagram illustrating an IP mobility mechanism comprising a home agent HA located in the internal backbone network 13. (Such a location is shown only as an example.) Reference numeral 18 in the lower-left hand corner of Fig. 1 denotes a protocol stack at such a prior art HA. The double-headed arrow illustrates routing of IP datagrams at the GGSN. Correspondingly, reference numeral 19 denotes a datagram comprising a payload portion PL and a number of headers H, one header for each of the protocols needed for routing the datagram. It is apparent that processing each datagram though a large number of protocol layers involves a large processing over-

head. Also, equipping each datagram with a large number of protocol headers wastes network capacity.

Fig. 2 illustrates an IP mobility mechanism comprising a home agent HA according to the invention, whereby the home agent HA is integrated into a GGSN node, commonly referred to as a gateway node. Reference numeral 20 denotes a protocol stack at the HA according to the invention. Correspondingly, reference numeral 21 denotes a datagram according to the invention. The datagram comprises a payload portion PL and one header H for each of the protocols needed for routing the datagram. It is apparent that the invention saves processing overhead and increases the throughput by decreasing the number of headers required in the datagrams.

If IPv4 is used, the HA intercepts datagrams addressed to the mobile station MS, encapsulates them and sends them to the MS's COA. The COA may be provided by a foreign agent FA, or it may be acquired by the MS itself using a technique such as the DHCP (Dynamic Host Configuration Protocol).

In known IP mobility mechanisms, foreign agents FA are typically installed as software routines in the mobile nodes MN. Fig. 1 shows an embodiment wherein foreign agents FA are installed in every SGSN node. (Such FA placement is the subject matter of Reference 1.) Each FA has an IP address in the Internet and in the operator's own private GPRS/3G network. For each SGSN/FA, a permanent packet data context exists in the corresponding gateway node GGSN to enable tunnelling towards the FA. One of the link protocols between an MS and the SGSN (e.g. Layer 3 Mobility Management, L3-MM) is modified to support IP mobility.

According to an alternative embodiment shown in reference 1, the foreign agent FA is integrated into a gateway node GGSN. In this case the MS uses as its COA the address of the FA in the gateway node. In order to establish mobility binding, the MS has to send additional information to the SGSN. Because of this additional information, the selected gateway node knows that a received IP address is valid although it does not belong to this particular gateway node. The gateway node detects registration messages from the MS and sends them to its FA unit for processing. This can be implemented easily if the gateway node's router unit sends all packets with a time-to-live field of zero to the FA. The advantage of this feature is that the gateway node does not have to study incoming packets in any great detail which would require

large amounts of processing power. Moreover, the gateway node GGSN/PDAN can accept any IP address from the MS and use the address of the FA as the MS's COA.

As a yet further alternative, the FAs can be dispensed with altogether, if IPv6 and a technique known as address autoconfiguration is used. The mobility support in IPv6 combines the concepts of Mobile IP and route optimization. Each time the MN moves its point of attachment from one IP subnetwork to another, it needs a COA from the current subnetwork. The MN may configure the COA by stateful or stateless autoconfiguration. (Stateful autoconfiguration relies on an address configuration server; in stateless autoconfiguration the MN picks an address and tries to find out if this address is already in use.)

The MN may send Binding Update messages, or 'options' to its correspondent nodes to let them dynamically learn and cache the MN's binding. Using the binding, the correspondent nodes may send their packets directly to the MN's COA. ('Option' is a term used in connection with IPv6 for certain optional headers inserted after the IPv6 header. Similarly, with IPv6, the word 'packet' is generally used for datagrams.) The Binding Update/Acknowledge Options are carried as IPv6 Destination Options and they may be included in any IPv6 packet. Destination Options are examined only by the packet's destination node, whereby the load of the intervening routers is not increased.

When sending a packet, a Correspondent Node checks its binding cache for an entry for the packet's destination address. If an entry is found, the Correspondent Node routes the packet directly to the MN's COA. An IPv6 Routing Header is used instead of IPv6 encapsulation. The Routing Header includes the MN's Home Address. If no entry is found, the Correspondent Node sends the packet normally to the MN's Home Network, wherein the HA intercepts the packet and tunnels it to the MN's COA using IPv6 encapsulation.

The description only illustrates preferred embodiments of the invention. The invention is not, however, limited to these examples or the terms used, but it may vary within the scope of the appended claims.

Reference

1. Finnish patent application [agent's reference 2980379FI], assigned and titled similarly and filed on the same day as the present application.

Claims

1. A method for providing Internet Protocol-type, or IP-type, mobility for a mobile station (MS) in packet radio network comprising:

at least one support node (GGSN, SGSN);

at least one support node being a gateway support node (GGSN) for interfacing with external networks (11), said gateway node supporting at least an IP-type protocol;

characterized by

integrating, into said at least one gateway support node (GGSN), a home agent (HA) for routing data packets to/from said mobile station;

supplementing said IP-type protocol with an extension for mobility management of said mobile station.

2. A method according to claim 1, characterized in that said gateway node comprises a protocol stack (18, 20) for supporting at least a layer 1 (L1) protocol, a layer 2 (L2) protocol, and a network layer (L3) protocol, and that said IP-type protocol resides on said network layer (L3); and said extension for mobility management is substantially a Mobile IP protocol.

3. A method according to claim 1 or 2, characterized by routing IP data packets to/from said integrated home agent/gateway node (GGSN+HA) using only the network layer (L3) protocol and the layer 2 and layer 1 protocols.

4. A method according to any one of claims 1 to 3, characterized in that the packet radio network comprises a foreign agent (FA) and a serving support node (SGSN), known per se, for supporting mobility management of the mobile station (MS); and that the foreign agent (FA) is integrated into at least one support node (SGSN, GGSN).

5. A method according to claim 4, characterized by integrating the foreign agent (FA) into at least one serving support node (SGSN).

6. A method according to claim 4, characterized by integrating the foreign agent (FA) into at least one gateway support node (GGSN).

7. A packet radio network for providing mobility service to a mobile station (MS), the packet radio network comprising at least one support node

(GGSN, SGSN) wherein at least one support node is a gateway support node (GGSN) for interfacing with external networks (11), said gateway node supporting at least IP-type protocol;

the packet radio network being characterized by an integrated network element (GGSN+HA) comprising the functions of the gateway support node (GGSN) and a home agent (HA) for routing data packets to/from the mobile station;

wherein said IP-type protocol comprises or is associated with an extension for mobility management of said mobile station.

8. A packet radio network according to claim 7, characterized in that the packet radio network comprises a foreign agent (FA) and a serving support node (SGSN), known per se, for supporting mobility management of the mobile station (MS); and that

the foreign agent (FA) is integrated into at least one support node (SGSN, GGSN).

9. A packet radio network according to claim 7 or 8, characterized in that the foreign agent (FA) is integrated into at least one serving support node (SGSN).

10. A gateway support node (GGSN+HA) for a packet radio network, arranged to provide mobility service for a mobile station (MS), wherein the gateway support node (GGSN+HA):

is interoperable with at least one serving support node (SGSN), for routing data packets to/from the mobile station (MS);

supports at least IP-type protocol;

the gateway support node being characterized by comprising the functions of the gateway support node (GGSN) and a home agent (HA) for routing data packets to/from the mobile station;

wherein said IP-type protocol comprises or is associated with an extension for mobility management of said mobile station.

11. Use of a gateway support node (GGSN) as a home agent (HA) for providing mobility service for a mobile station (MS) in a packet radio network, wherein the gateway support node supports at least an IP-type protocol, and said IP-type protocol comprises or is associated with an extension for mobility management of said mobile station.

1/1

Fig. 1

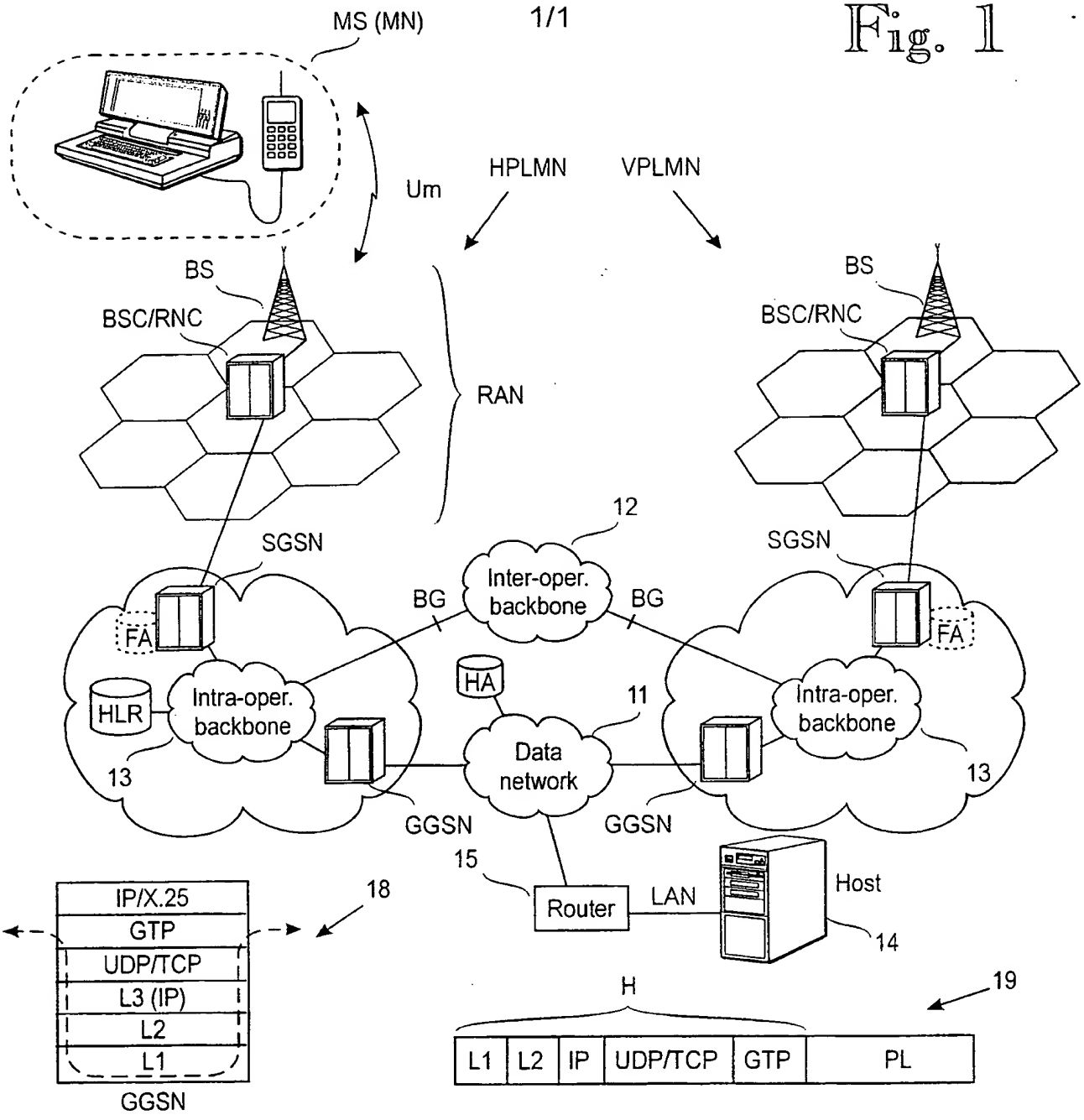
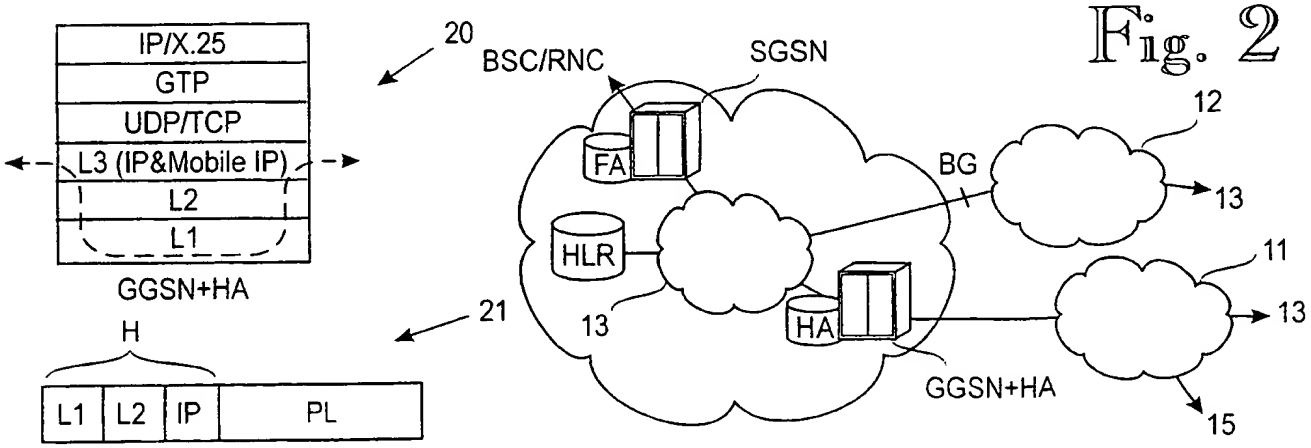

MS (MN)
Um
HPLMN
VPLMN
BS
BSC/RNC
RAN
SGSN
12
Inter-oper. backbone
BG
FA
HA
HLR
Intra-oper. backbone
11
Data network
13
GGSN
15
Router
LAN
Host
14
18
IP/X.25
GTP
UDP/TCP
L3 (IP)
L2
L1
GGSN
19
H
L1
L2
IP
UDP/TCP
GTP
PL

Fig. 2


20
IP/X.25
GTP
UDP/TCP
L3 (IP&Mobile IP)
L2
L1
GGSN+HA
21
H
L1
L2
IP
PL
BSC/RNC
SGSN
FA
HLR
HA
BG
12
13
11
15
GGSN+HA